Horizontal distribution of ectomycorrhizal infection in *Dipterocarpus turbinatus* plantations of Bangladesh

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Abstract: Garjan (*Dipterocarpus turbinatus* Gaertn. F) is a highly ectomycorrhizal tree species growing in hilly areas of Bangladesh. The horizontal distributions of ectomycorrhizas (ECM) in different distances (1, 2, 3 & 4m) from the tree base were determined in 5, 10 and 20-year-old *D. turbinatus* plantations of Chittagong University Campus (CUC) in 2003. The ECM infection (%) in roots was counted at three hill positions (top, mid and bottom) for each of the plantations. Samples of 1000 cm^3 rhizosphere soil were collected from underneath the trees at different horizontal distances. The percentage of infection at different distances and hill elevations varied considerably. In 5 and 10-year-old plantations, the occurrence of infection (%) was rapidly declined with increasing distances，while in 20-year-old plantation, the infection increased sharply with increasing distances from the tree base. The highest infection (81.33%) was found at 4 m distance from the tree at bottom hill in 20-year-old plantation and the lowest (55.33%) at the same distance at the top of the hill in 5-year-old plantation.

Keywords: *Dipterocarpus turbinatus* plantation; Garjan; Ectomycorrhizas; Horizontal Distribution; Infection; Bangladesh
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Introduction

Dipterocarpus turbinatus, locally known as 'Telly Garjan', is a commercially important timber species naturally grown in Hill Forests of Bangladesh. It also grows in tropical evergreen and semi evergreen forests of the Andamans, greater part of Myanmer, Chittagong Hill Tracts and Cox's Bazar. The wood is good for making lorry bodies, boat building, railway sleepers, transmission poles and other construction purposes (Das 1980). Mycorrhizas are the symbiotic association between specialized root inhabiting fungi and the roots of living plants (Lee 1998). They play a significant role in plant nutrition, growth improvement, successful afforestation, reforestation, bio-control of pathogens and land reclamation programmes (Marx 1977; Rawat *et al.* 2003). All members of the Dipterocarpaceae so far examined are ectomycorrhizas (Singh 1966; Bakshi 1974; Hong 1979; de Alwis and Abeyanake 1980; Ashton 1982; Becker 1983; Alexander and Högberg 1986; Smits 1994; Aniwat 1987; Hadi and Santoso 1988 and Hadi *et al*. 1991). They increase the tolerance of trees against drought, high soil temperatures, organic and inorganic toxins and extreme soil acidity (Lee 1998). Although a considerable amount of work was done on ECM in different parts of the world (Becker 1983; Hadi and Santoso 1988; Yasman 1993; Zarate *et al*. 1993), little has been done in Bangladesh (Shayesta and Choudhury 1985; Rahman and Mridha 2004). The present study was undertaken to explore the horizontal distribution of ECMs in 5, 10 and 20-year-old *D. turbinatus* plantations at three hill positions (top, mid and bottom).

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Materials and methods

Study site

The study was carried out in 5, 10 and 20-year-old *D. turbinatus* plantations on hills of Chittagong University Campus (CUC), Bangladesh. The area lies between about 22º27′30″ and 22º29′0″ North latitudes and 91º46′30″ and 91º47′45″ East longitudes and covers about 1,271 acres of land approximately (Anon 1989). The hills are low to medium high and slope ranges from gentle to steep (Anon, 1979). Soils are yellowish brown to yellowish red loamy sand and weak to strong blocky. The sandy loam soil had moisture content around 25 percent and pH 5.6.

Assessment of ECM infection at various distances from a tree

In April 2003, ECM root samples were collected from points 1, 2, 3 and 4m apart from the base of a tree at three slope positions (top, mid and bottom) of each plantation. Three soil samples for each distance were randomly collected. To determine the horizontal distribution of ECMs, root samples along with rhizosphere soils (1000 cm^3) were taken. Each collected sample was transferred into a separate plastic bag and marked. All samples were brought to laboratory to examine ECM association in the root tips. Fine feeder roots i.e., short roots were washed over 0.2 mm mesh-size sieve using a gentle flow of tap water. Then the short roots were transferred to the petri dishes and observed under compound microscope. The presence of ECMs in root tips was determined with the help of laboratory manual (Ingleby *et al*., 1990). From each sample 100 fine roots were examined. When there were less than 100 fine roots all of them were examined and recorded. Then the percentage of ECM infection was calculated by using the following formula:

$$\text{ECM infection (\%)} = \frac{\text{Total number of infected root tips}}{\text{Total number of root tips studied}} \times 100$$

Results

Distances from the tree base influence the formation of ECM root infection. The observations of such infection in plantations of three different ages (20, 10 & 5 years) are presented in Figures 1, 2 & 3. The occurrence of ECM infection (%) increased with distance from tree base in 20-year-old plantation (Figure 1). The highest infection (81.33%) was found in 4 m distance from the tree at bottom hill and the lowest (61.67%) at 1m distance at top hill position. It has been found in Figure 2 that the infection (%) was rapidly climbed between 1m and 2m distances from trees in 10-year-old plantation and then decreased gradually up to 4 m one. Maximum infection (73.33%) was recorded in 2m distance from the tree at the bottom and minimum (61.00%) was in 1m distance at top hill (Figure 2). In case of 5-year-old plantation, the percentage of ECM infection was gradually increased up to 2 m distance and then it declined sharply. The highest infection (74.33%) was found in 2 m distance at the bottom while the lowest (55.33%) –in 1 m at the top of the hill (Figure 3).

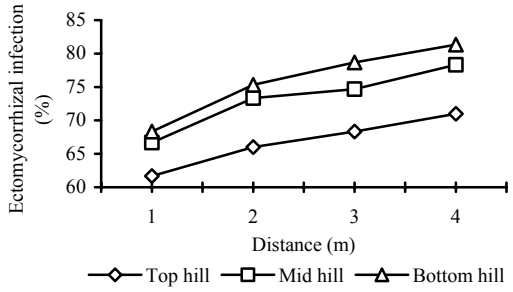

Fig. 1 ECM infection (%) in soil at 1, 2, 3 and 4m distances from the tree at three hill positions of 20-year-old *D. turbinatus* plantation

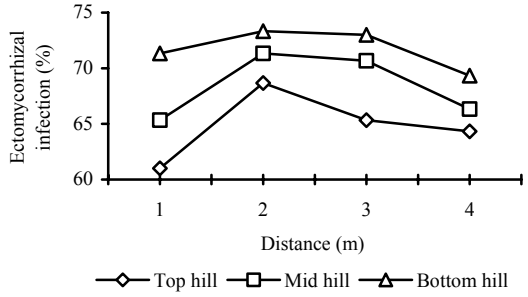

Fig. 2 ECM infection (%) in soil at 1, 2, 3 and 4m distances from the tree at three hill positions of 10-year-old *D. turbinatus* plantation

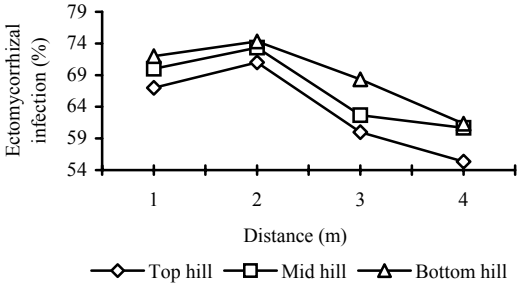

Fig. 3 ECM infection (%) in soil at 1, 2, 3 and 4m distances from the tree at three hill positions of 5-year-old *D. turbinatus* plantation.

The comparisons of ECM infection (%) in 5, 10 & 20-year-old plantations at top, mid and bottom hill positions are presented in Figures 4, 5 and 6, respectively. According to the age of plantations, the comparison of infection at different hill elevations varied considerably. At the top hill position the maximum infection was 71.00% found in 4 m distance in 20-year-old plantation compared with 10 and 5-year-old plantations (Figure 4). In the middle of the hill, the highest infection was 78.33% in 4 m distance from the base of the tree in 20-year-old plantation and the lowest was 60.67% in 1m distance in 5-year-old plantation (Figure 5). In case of bottom hill position, the infection was found highest in 20-year-old plantation followed by 10-year and 5-year old plantations (Figure 6).

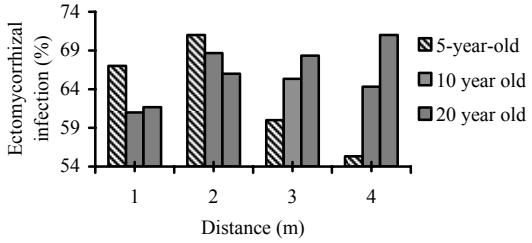

Fig. 4 Comparison of ECM infection (%) in soil at different distances from the tree at top hill position in 5, 10 and 20-year-old *D. turbinatus* plantations

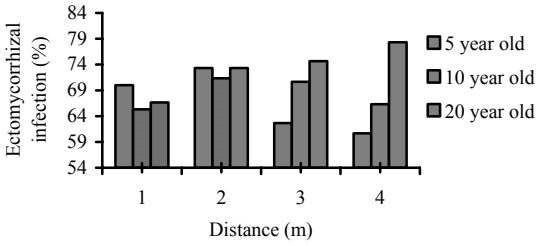

Fig. 5 Comparison of ECM infection (%) in soil at different distances from the tree at mid hill position in 5, 10 and 20-year-old *D. turbinatus* plantations

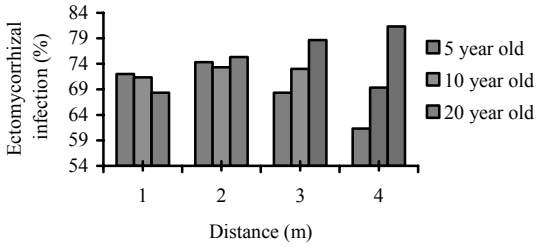

Fig. 6 Comparison of ECM infection (%) in soil at different distances from the tree at bottom hill position in 5, 10 and 20-year-old *D. turbinatus* plantations

Discussion

Most of the ECM roots were found in 1m and 2m distances from the trees in 5-year and 10-year-old plantations. With increasing distances, the percentages declined rapidly. In 20-year-old trees, the ECM infection (%) sharply increased with increasing distances from the base of the trees in three hill positions. Such a distribution ECM roots might be a general tendency

in natural mature forests, and it might be related to the existence of high amounts of nutrients that are available for plant roots and fungi. 95.4%, 83.5%, 76.4%, and 86.4% of root tips were found ectomycorrhizal in a survey of *Shorea leprosula* and *S. curtisii* in an underlogged and logged forest in Malaysia (Lee and Lim, 1987). The tendency of fine roots and ECM roots being mainly at the soil surface was found in various natural mature forests, including both broad-leaves and conifers (Büttner and Leuschner, 1994). The similiar results were also found by Kimmins and Hawkes (1978), Vogt *et al*., (1981), Ehrenfeld *et al*., (1992) and Hashimoto and Hyakumachi (1998). Alexander *et al.,* (1992) reported that the ECM infection (%) declined markedly in distances greater than 30 meter from *D. costulata* tree. The proportion of living roots with ECMs remained high, at about 83%, above 30 cm depth in a *Betula pubescens* and *B. pendula* stand (Ingleby *et al.*, 1985). The percentage of ECM infection was found highest in mid hill position in 20-year-old pine trees at CUC in Bangladesh (Rahman and Mridha, 2004). Their result, showing a high concentration of ECM roots at the surface of the soil, was the same with present study.

Mycorrhization of forest crops has attracted considerable attention over the last few years because of their role as biofertilizers (Mridha, 2002), improving host growth as well as contributing to disease suppression (Marx, 1972). Hence, the appropriate association of ECMs with *D. turbinatus* is of considerable significance and needs further study and exploitation.

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